MULTI-LAYER MICROFLUIDIC DEVICES FOR AMINO ACID ANALYSIS: THE MARS ORGANIC ANALYZER

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Astrobiology on Mars

- Recent MER results:
  - Sedimentary and mineralogical evidence of past liquid water
  - Jarosite is key evidence

- What do we look for?
  - Broad classes of molecules including organic sugars and bases (i.e. nucleobases), amines and amino acids
  - Amino acid homochirality necessary for life
Amino Acid Analysis


Fluorescamine (FA) Derivatized amino acid (absorption max @ 390 nm)

Composition

Chirality
You are here
Microfabricated device contains two 21-cm long separation channels

Microfabricated channels formed by bonding 2 glass layers together
Microfabricated Valves

Microfabricated Pumps

- 14 distinct pumps (42 valves) operated by 3 pneumatic lines
- Input / output valves are 500 x 700 \( \text{m} \)
- Diaphragm valves range from 1.5 to 3 mm (large axis)
- Flow rates from 1 nL/s up to 2 \( \text{L} / \text{s} \) are achievable
**Multilayer Devices**

• 4-layer device for microfluidic sample handling and CE separations

Portable CE Instrument: Mars Organic Analyzer (MOA)

A.M. Skelley et al. (2005) PNAS 102, 1041-1046.
Lab-Based Characterization of MOA

• Microfabricated CE analyzer has demonstrated pM and parts-per-trillion sensitivity

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Lab-Based Analysis of Atacama Samples using MOA
• The MOA successfully analyzed amino acids from soil samples at the dry limit of microbial life on Earth

Field Testing of MOD-MOA on Mars-Like Samples
Field Testing of MOD-MOA on Mars-Like Samples

- MOD-MOA combination successfully analyzed amino acids in the field
- Significant amino acid biomarkers are found in acidic jarosite soils

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MAP: The Mars Astrobiology Probe

Sample receiving system

Electronics box

LIF detector
MOD oven

_CE system and LIF
Development of Automated, Multi-Sample Instrument

- Device is fixed on instrument prior to flight
- Scanning objective locates channel prior to analysis

- 8 separation channels
- 2-stage bus
- 32 pneumatic lines
The Multi-Channel Mars Organic Analyzer (McMOA)

- Aluminum Case: 10” x 12” x 4”
- Chip and Chip Manifold
- 32 Pneumatic Lines
- Chip Cooling Platform
- Optical Components
- Stepper Motor
Summary and Future Applications

• Demonstrated complex microfluidic systems, CE multilayer device

• Developed portable instrumentation

• The fully integrated MAP is being developed for the Pasteur payload on the 2009 ExoMars (ESA) mission

• Applicable for future astrobiology missions – currently investigating analysis of other classes of biomolecules

• Devices and instrumentation developed are applicable and currently being used for forensics, sequencing, pathogen detection
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